International Journal of Business
Management & Research (IJBMR)
ISSN(P): 2249-6920; ISSN(E): 2249-8036
Vol. 5, Issue 1, Feb 2015, 61-70

RELATIVE IMPORTANCE ANALYSIS: PREVENTION SYSTEM OF PILOT'S HUMAN ERROR

WOO-CHOON MOON, HYUN-TAE JUNG & YE-JIN PARK

Korea Aerospace University, Goyang City, Republic of Korea

ABSTRACT

Since the late1950s, the aviation sector for the multilateral effort to reduce accidents through safety level is improved. Over the last few years, the overall accident rate, including environmental and mechanical factors, decreased, but pilot error-related accidents are unfortunately are not reduced. Today, a very large proportion of fall aviation accidents are pilot error, directly or indirectly, to be derived from several factors. As a result of many studies, prevention systems of pilot error, as like CRM, LOFT, LOSA, SMS, FRMS, etc., have been developed, to be presented. However, a number of different the prevention systems are disruptive to the air transport operator. Therefore, in this study, prevention systems of pilot error were introduced in detail. The relative importance analysis of prevention systems was presented.

KEYWORDS: Pilot Error, Prevention System, Line-Oriented Flight Training, Safety Management System, Crew Resource Management, Fatigue Risk Management System

INTRODUCTION

As the size and performance in aircraft has been greatly developed, the demand of air traffic was rapidly accelerated. Furthermore, as a long-distance flight had been come true, we, the globalized world, got into a one-day life zone. However, because of the characteristic of air traffic as a three-dimensional transportation, incalculable damage among the passengers and property even the death of all passengers can be caused once an accident occurs. Thus, pilots should never make any mistake. However, human as the pilot just like us can make an error even in the normal or abnormal situation.

Fortunately, aircraft accident rate has been sharply decreased since 1950 as a consequence of our effort to reduce such rate focusing on safety regulation, training, development of aviation equipment, recognizing that pilot error is inevitable. However, the prominent decrease of aircraft accident rate has been slowdown since 1977. Since 1980s, it has been seen that there is no noticeable tendency of aircraft accident rate reduction [1]. Between 1994 and 2003, the percentage of human factors in overall commercial aircraft accidents was calculated as more than 60%.Although equipment-related accidents have been reduced due to the development of aviation technology, human-related accident rate has remained stationary. Factors of accident vary in cause; increased volume of air traffic, accumulated wok hours resulted from long-distance flight, complicated flight environment. "Errors" can be verbalized as mistake, fault, failure, etc. These expressions are different in nuance, but same in meaning; different result from one's intention and even the expectation. Error is a natural psychological phenomenon appeared in normal action. Thus, errors do not always relate with accident. For instance, even when the pilot does not make the gear down, the error can be corrected by warning lights of aircraft or alerting from tower [2].

Anyway, accident occurs from accumulated small errors in normal or abnormal operation, not from single error. Thus, numerous researches on pilot errors, the most critical issue in aviation, have been implemented. ICAO(International Civil Aviation Organization), since 1990, has suggested a three-year period "Human Factors seminar about aviation safety", in which each government of the member nations, academia, airlines, aviation organization, aviation association, research institution and other relatives took part as a part of service to prevent accidents. However, the organization could not succeed to concentrate on an effective one of various existing pilot error prevention systems.

In this study, the relative importance of pilot error prevention system is presented. Government officials, academic experts and pilots were surveyed. Through this process, present and future implications to contribute to prevention system of pilot error.

PREVENTION SYSTEM OF PILOT ERROR

Introduction

The importance of focusing on pilot errors has been increased in Aviation. Even the trivial carelessness can cause significant problem in safety and productivity. The definition of pilot error is the mistake of decision and the failure of operation such as carelessness, misconception, mistake, guess, negligence, etc.

The Prevention systems of pilot error are as follows; LOFT, LOSA, SMS, CRM, FRMS, etc.

Types and Contents of Pilot Error Prevention System

LOFT (Line-Oriented Flight Training)

LOFT is a kind of pilot training system that adjusts the collected data during the real flight and applies it into the simulating conditions. LOFT is purposing flight training and feedback. The objective of LOFT is to train communication, resource management, leadership, etc. In this training, the real data is used for pilots to reflect the real flight condition. Thus, it is possible to train pilots to experience the situation which seems not to happen in real flights, and emergency situations, etc. This is for team synergism by reflecting real flight condition into simulator and providing flight maneuver training and full mission simulation in abnormal situation. Different with those other simulators which depend only on one's flight technique in normal, LOFT provide proper handling method in abnormal or emergency situation with flight maneuver training and full mission simulation..

LOSA (Line Operation Safety Audit)

LOSA is the latest flight safety program purposing to gain flight data and improve safety of flight, not to evaluate or supervise pilots. Observer who completed the training course may collect the data related with safety. Then, these data may properly be used as a method of correction and prevention. There are some operational characteristics of LOSA stated in ICAO.

- Observe the pilots in normal situation
- Utilize anonymous and secret data
- Volunteer of pilots
- Guarantee of the company and pilot union
- Collecting form of safety related data

- Creditable and well-trained observer
- Place for protection of collected information
- Examination of data reliability and using data safety improvement
- Feedback

In LOSA, pilot should operate the flight as usual and the observed date should be kept secret following to the agreement between labor and management. Then, the encoded data will be transferred to LOSA operation agency to be used on safety management.

SMS (Safety Management System)

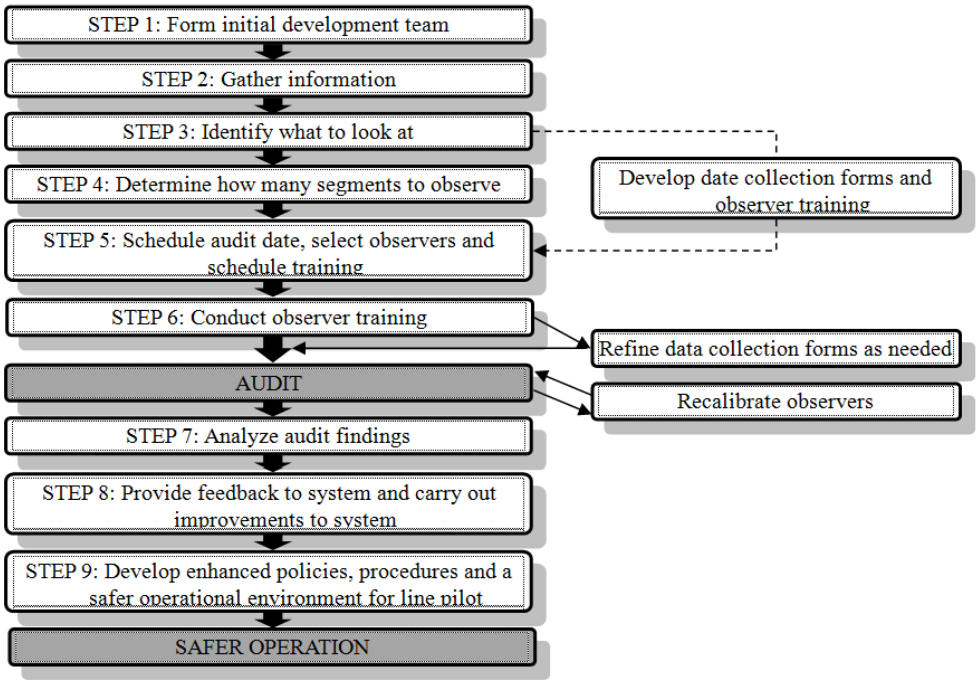

Figure 1: Key Steps of LOSA [3]

Safety in aviation has always been a hot issue among aviation related institution, government and the public. Safety means that incident or accident can be handled with an acceptable level. Safety management is to maintain those situations to be safe in always. SMS is a precise and systematic pre-active safety management system based on safety management paradigm, including organization, responsibility, procedure, process, regulation, etc. SMS has 70% similarity in both definition and component with QMS (Quality Management System). Also, some terms like Risk management or Safety Access has already been wide spread in organizational culture. The difference between these systems is object and cognition among human factors and organizational factors. The ultimate goal of QMS is to enhance the quality and it recognizes that human factors and organizational factors have impact on the risk. Here is the constructing factors in requirement and procedures of safety management system; safety policy, safety management activities, organization, etc [4].

- Safety policy
- Safety management activity

- Safety performance monitoring
- Safety assessment
- Safety auditing
- Safety promotion

- Safety management organization
  - Safety management organization structure
- Safety manager
- Safety responsibility and accountability
- Training and competency

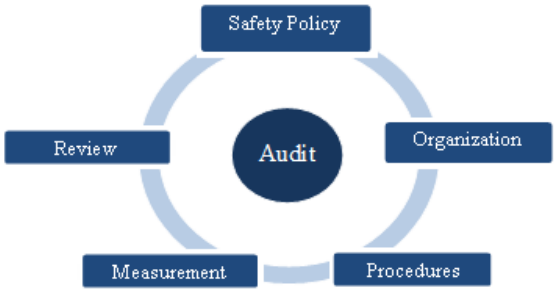

Figure 2: Safety Management Cycle

CRM (Crew Resource Management)

CRM had been originated from the effort to respect other's opinion of aircraft operation in early 1970s. It is the step of harmonizing to increase the effectiveness. CRM, started as Cockpit Resource Management, expanded its range of application among not only the pilot and cabin crew but also the person engaged in aviation business including controller, dispatcher, engineer, manager, etc. That is, CRM provide the management among every usable resource for safe and efficient flight. Thus, it is possible for pilots to make a proper decision through the teamwork. The objective of CRM which is the most effective safety program in aviation society is to optimize the communication skills and cockpit managing ability of every crew member, thus they can make safe and efficient decision at every moment.

FRMS (Fatigue Risk Management System)

Fatigue is a major human factors hazard because it affects most aspects of a crewmember's ability to do their job. It therefore has implications for safety. The fatigue of pilots is closely connected with aircraft accident. In order to low performance resulted from pilot fatigue is not a personal problem, it is essential to manage the fatigue risk factors and enhance the safety through scientific, systematic and comprehensive fatigue management. An FRMS aims to ensure that flight and cabin crew members are sufficiently alert so they can operate to a satisfactory level of performance [5].

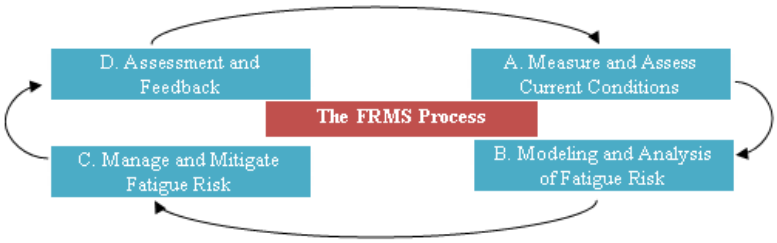

Figure 3: Fatigue Risk Management Systems (FRMS) Process [6]

EMPIRICAL ANALYSIS ON RELATIVE IMPORTANCE IN PREVENTION SYSTEM OF PILOT ERROR

Methods and Process of Experiment

In order to carry out the experiment, we used AHP (Analytic Hierarchy Process. This process is used around the world in a wide variety of decision situations thus, it is possible to organize and analyze such complex decision.

In this process, decision making problem may be decomposed into a hierarchy of mutually related sub-problems. Then, the data for decision may be derived from pair wise comparison.

Such analysis is different from the selection of experts at every moment. However, it is applicable because most related experts exposed almost same evaluation.

There are about 4,500 airlines pilots are working in the Republic of Korea, including schedule airlines, nonscheduled airlines, private pilots, etc. To evaluate the relative importance of prevention system of pilot error, at first, we divided the systems into big items and small items through survey applied among relative experts. Secondly, we implemented survey about the importance of those systems among pilots, government personnel and persons in academia.

To enhance the degree of understanding, each research includes summarized explanations of prevention system. We implemented researches about the relative importance of 5 big items and 16 small items. Each item is in the below table 1 and table 2

Table 1: Prevention System of Pilot Error (Big Items)

Influence Factors Big Items	Explanation
LOFT	A kind of pilot training system which adjust the collected data during the real flight and applies it into the simulating conditions, purposing flight training and feedback
LOSA	The latest flight safety program purposing to gain flight data and improve the safety of flight, not to evaluate or supervise the pilots
SMS	A precise and systematic pre-active safety management system based on safety management paradigm, including organization, responsibility, procedure, process, regulation, etc
CRM	A cockpit resource management to prevent human related accident through the improvement of interaction among pilots
FRMS	Applied system that manages fatigue risk factors because of the close connection between pilot fatigue and aircraft accident,

Table 2: Prevention System of Pilot Error (Small Items)

Influence Factors		Explanation
Big Items	**Small Items**	
LOPT	Briefing	Observer explains LOFT scenario and his roll before the beginning of training
	Preflight preparation	Preflight procedure and plan(Weather report & Flight plans) includes the preparation coincide with airline's needs
	Flight Segment	Divide flight segment as taxi, climb, cruise, approach, arrival and include the communication with ATC and relative institution
	De-briefing	The most important part of LOFT, carry out the feed-back of actions during the training to enhance the effectiveness after the end of LOFT
LOSA	Protection for pilots	To protect the pilot, observer never record pilots name, flight number, date and any other information related with identity
	Selection and training of creditable observer	The company and labor union negotiate the selection of observer among volunteers
	Management of observed data	Transfer the observed data to LOSA operation agency, then check the error and manage it
SMS	Safety policy	Publicize safety management policy and suggest the priority of safety and safety objective
	Safety management activities	Include safety performance monitoring, safety assessment, safety auditing, safety promotion, etc.
	Safety management organization	Include the safety management organization structure, roll of safety manager, responsibility and duty of safety manager, propriety and training, etc.
CRM	Team Work	Enhance the teamwork among not only the captain and co-pilot but also the cabin crew as horizontal relationship, not vertical relationship
	Culture	Prevent the culture gap between the captain and co-pilot
	Leadership	Enhance the handling skills once unpredictable situation happens by increasing the leadership
FRMS	Working hours	Time from briefing to operator or the beginning of work to the end of all task
	Break time	The time that pilots get off from any task given by flight license holder
	Sleeping hours	Sleeping hours before the begging of operation

Analysis of Relative Importance

In this study, 39 questionnaires; 12 for pilot, 20 for government personnel and 7 for academic experts are used excluding inconsistent questionnaires.

Relative Weight of the Comparison Top-level Attributes

5 big items of prevention system of pilot error are composed with LOSA, LOFT, SMS, CRM and FRMS. The relative weights of the comparison top-level is in the below table 3.

Table 3: Relative Weights of the Comparison Top-level Attributes

Big Items	Pilot		Government Personnel		Academic Experts	
	Weight	Ranking	Weight	Ranking	Weight	Ranking
LOFT	0.160	4	0.256	1	0.075	5
LOSA	0.110	5	0.186	3	0.130	3
SMS	0.339	1	0.170	4	0.509	1
CRM	0.192	3	0.164	5	0.123	4
FRMS	0.199	2	0.224	2	0.162	2

As a result, pilots and academic experts claimed that SMS is the most important factor. On the contrary, LOFT was the most important factor for government personnel.

Pilots prioritized big items as SMS>FRMS>CRM>LOFT> LOSA. Academic experts was SMS>FRMS>LOSA>CRM>LOFT. However, the government personnel prioritized them as LOFT>FRMS>LOSA>SMS>CRM. This is because of the difference of position. For government personnel is a voluntary and active safety management of aircraft operators, as like LOSA, considered more important than SMS. Academic experts and pilots is a systematic approach to human error, SMS, considered more important than the airline's LOSA.

Relative Weight of the Comparison Sub Attributes

16 small items of prevention system of pilot error are composed with briefing, preflight preparation, flight segment, de-briefing, protection for pilots, selection and training of observer, management of observed data, safety policy, safety management activities, safety management organization, team work, culture, leadership, working hours, break time and sleeping hours. The relative weights of the comparison sub attributes are in the below table 4.

Table 4: Relative Weights of the Comparison Sub Attributes

Small Items	Pilots	Government Personnel	Academic Experts	Small Items	Pilots	Government Personnel	Academic Experts
Briefing	0.024	0.098	0.010	Safety management activities	0.129	0.066	0.212
Preflight preparation	0.027	0.095	0.041	Safety management organization	0.141	0.059	0.236
Flight Segment	0.066	0.099	0.018	Team Work	0.080	0.063	0.035
De-briefing	0.033	0.073	0.006	Culture	0.043	0.038	0.038
Protection for pilots	0.043	0.052	0.014	Leadership	0.038	0.023	0.050
Selection and training of observer	0.046	0.072	0.105	Working hours	0.045	0.042	0.022
Management of observed data	0.029	0.037	0.012	Break time	0.066	0.057	0.043
Safety policy	0.105	0.039	0.061	Sleeping hours	0.083	0.087	0.097

Relative Weight of the Comparison Sub Attributes

By integrating the results of relative weight comparison, we computed out the final relative weight of the comparison attribute.

Table 5: Final Relative Weights of the Comparison Attributes

Ranking	Pilot		Government Personnel		Academic Expert	
	Weight	Importance	Weight	Importance	Weight	Importance
1	Safety management organization	14.10%	Flight segment	9.90%	Safety management organization	23.60%
2	Safety management activities	12.90%	Briefing	9.80%	Safety management activities	21.20%
3	Safety policy	10.50%	Preflight preparation	9.50%	Observer selection &training	10.50%
4	Time limitation	8.30%	Time limitation	8.70%	Time limitation	9.70%
5	Team work	8.00%	De-briefing	7.30%	Safety policy	6.10%
6	Flight segment	6.60%	Observer selection &training	7.20%	Leadership	5.00%
7	FRMS	6.60%	Safety management activities	6.60%	FRMS	4.30%
8	Observer selection &training	4.60%	Team work	6.30%	Preflight preparation	4.10%
9	Time limitation	4.50%	Safety management organization	5.90%	Culture	3.80%
10	Pilot protection	4.30%	FRMS	5.70%	Team work	3.50%
11	Culture	4.30%	Pilot protection	5.20%	Time limitation	2.20%
12	Leadership	3.80%	Time limitation	4.20%	Flight segment	1.80%
13	De-briefing	3.30%	Safety policy	3.90%	Pilot protection	1.40%
14	Data management	2.90%	Culture	3.80%	Data management	1.20%
15	Preflight preparation	2.70%	Data management	3.70%	Briefing	1.00%

As a result, the importance of pilot error prevention system has revealed as safety management organization then safety management activities for pilot and academic experts. This means pilot and academic expert seem that they recognize SMS with the lead of government is the most important factor to prevent pilot error.

However, government personnel assessed important flight segment and briefing.

CONCLUSIONS

In this study, for the prevention of human errors among many alternatives by identifying the relative importance and priority of effective human error prevention activities was to provide basic data and suggestions.

Analysis of the importance of this research, pilot and academic experts, in the case of two groups, SMS will be given a relatively high weight. On the other hand, government officials is a voluntary and active safety management of airlines, as like LOSA, considered more important than SMS. These visual differences between the groups that pilot error prevention activities in the future are expected to confusion in the process. To prevent this, it is necessary to structure and integrate the various prevention systems.

Unfortunately, we predict new version of pilot error prevention system may appear continuously. Such inconsistent appearance of various systems may confuse our aviation safety society and disturb the existing systems to be participated and cooperated. Thus, to implement the prevention system of pilot error effectively, we should find out the most appropriate system, as like SMS or new system, and concentrate on it. Moreover, to enhance the efficiency of pilot error prevention activity, we should organize and enforce prevention system of pilot error based on mutual understanding and cooperation of every single participant.

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